

## DETERMINATION OF SUITABLE DRYING TECHNIQUE AND SLICE SIZE FOR DEHYDRATION OF GARLIC

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### ABSTRACT

*An experiment was conducted with the aim to investigate the most suitable drying technique and slice size for dehydration of garlic. Among various treatment combinations the minimum time (0.45 h) taken for drying was observed in S<sub>1</sub> (1 cm slice) under D<sub>3</sub> (Microwave drying), whereas maximum time (30 h) was observed in S<sub>4</sub> (Whole clove) under D<sub>1</sub> (Solar drying). Highest weight loss (75.16%) was recorded in S<sub>1</sub> under D<sub>1</sub> and lowest weight loss (68.50%) was recorded in S<sub>4</sub> under D<sub>2</sub> (Mechanical drying). Final weight (44 g) was highest in S<sub>4</sub> under D<sub>2</sub> while the lowest (39.83 g) was recorded in S<sub>1</sub> under D<sub>1</sub>. The treatment combination of S<sub>4</sub> under D<sub>2</sub> (whole clove x mechanical drying) was found best for most of parameters of dried garlic slices.*

**KEYWORDS:** Drying Method, Drying Time, Final Weight, Garlic & Slice Size

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### INTRODUCTION

Garlic bulbs are harvested when the majority of leaves turn yellow show signs of dry down. Generally, garlic crop is ready to harvest in 130 to 180 days after planting depending upon the variety, soil and climatic conditions. Early harvest results in poor quality of bulbs which cannot be stored for longer period. Delayed harvest results in splitting and also sprouting of bulb in some varieties. In India, harvesting is done manually by pulling out the crop by khurpi. Bulbs are removed along with tops. It is observed that garlic grown in Gujarat was the biggest and the best, giving the highest recovery of dehydrated peeled garlic and garlic powder of good pungency and antibacterial activity (Pruthi *et al.*, 1959) dehydrated garlic is also used in the pharmaceutical preparations like garlic capsule and tablets.

Garlic is the only spice in the spices kingdom which has all the vitamins, minerals as well as the trace elements. It is a rich source of protein, minerals like P, K, Ca, Mg, and S. It also contains vitamin C and has got a reasonably high calorific value. Ascorbic acid content was found to be high in green garlic. The ancient physician of India, Charaka mentioned "if one chews garlic everyday and swallows its juice, he or she will be free from all diseases" (Lews, 1991). Garlic is carminative, gastric stimulant and also used for treatment of many diseases since time immemorial in our country. The blood sugar lowering effect of garlic was ascribed to allicin and related disulphide containing compounds.

Garlic is mainly processed in the form of dehydrated products for use in curries and soup powders. International standard for dehydrated garlic and garlic powder, colour should be between white and pale cream. Garlic is an important spice crop which is harvested from December to March. Its pungency and flavour gives

specific taste to Indian dishes. To make use of the bulbs, they have to be peeled and individual cloves, have to be separated. It consumes time of the modern era house wives so, if the garlic bulbs are dried/ dehydrated after peeling and separating the individual cloves, they become ready to use.

Today garlic is used for its flavors, aroma and taste being prepared domestically or farming, a raw material for a variety of food manufacturing processes, dehydration and pickling. Powder prepared from the dehydrated or dried garlic slices can be used for seasoning of fishes and meat apart from using it as a spice. Therefore, keeping the above points in view "Determination of suitable drying technique and slice size for dehydration of garlic" was planned.

## MATERIALS AND METHODS

The present experiment was conducted in the Department of Postharvest Management, College of Horticulture, Mandasaur in Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior during the year 2009-2010. Freshly harvested garlic cloves and slices were used for the study. The garlic variety Yamunasafed-3 (G-282) was procured from the local market. Damaged, diseased, and immature bulbs were sorted out and fresh garlic produce was selected for the study. The sample of 150 g was weighed for different treatments after initial chemical analysis of fresh garlic bulbs. For single replication nearly 4 Kg of garlic sample was taken for the investigation. Drying/dehydration of garlic slices were carried out in aluminum trays of size 12" x 8" x 1/2". Slices were made with the help of sharp edged knife (Stainless steel, Glare Steak 210 mm knife). Four types of slices (chopped, 1cm slice, half of the whole clove and whole clove of garlic) were prepared.

For different treatment combinations, one variety, three levels of drying methods (solar, mechanical (at 45 °C) and microwave drying) and four levels of slice size (chopped, 1 cm slices, half of the whole clove and whole clove) were planned. During the drying period the microwave was applied at maximum power level (1.2 KW, 2450 Mhz) for 60 seconds and power off for 15 seconds (Baysal *et al.*, 2003). Thus, 12 treatment combinations were dried in the present investigation. The experimental details and various treatment combinations are presented in Table 1. Ambient temperature was determined with the help of minimum and maximum thermometer (Zeal - Made in England, Capacity - 0°C to 50°C). Relative humidity was measured through digital hygrometer (make Vista Biocell Pvt. Ltd. New Delhi, INDIA). Dry bulb and wet bulb temperatures were also used to calculate the relative humidity with the help of psychometric chart. The drying characteristics, drying time, final weight were recorded during the experiment. The sensory evaluation/organoleptic analysis were done in terms on hedonic rating tests by a trained panel. The organoleptic parameters viz., colour, aroma, taste and texture of dried garlic slices were analyzed on 1-9 point scale (Ranganna, 1986). The weight of dehydrated garlic slices at the end of the drying obtained from each treatment was noted down and the loss g/100 g fresh weight was calculated by the following formula:

$$\text{Loss in weight} = \text{Fresh weight} - \text{dried weight}$$

To test the significance of variation in the data obtained, the analysis of variance technique was adopted as suggested by (Sahu and Das, 2009) for Completely Randomized Design. Significance of the difference in the treatment effect was tested through "F" test.

**Table 1: Various Treatment Combinations**

S. No.	Slices Size	Method of Drying	Symbols
1	Chopped	Solar drying	S <sub>1</sub> D <sub>1</sub>
2	Chopped	Mechanical drying	S <sub>1</sub> D <sub>2</sub>
3	Chopped	Microwave drying	S <sub>1</sub> D <sub>3</sub>
4	1 cm slices	Solar drying	S <sub>2</sub> D <sub>1</sub>
5	1 cm slices	Mechanical drying	S <sub>2</sub> D <sub>2</sub>
6	1 cm slices	Microwave drying	S <sub>2</sub> D <sub>3</sub>
7	Half of the whole cloves	Solar drying	S <sub>3</sub> D <sub>1</sub>
8	Half of the whole cloves	Mechanical drying	S <sub>3</sub> D <sub>2</sub>
9	Half of the whole cloves	Microwave drying	S <sub>3</sub> D <sub>3</sub>
10	Whole cloves	Solar drying	S <sub>4</sub> D <sub>1</sub>
11	Whole cloves	Mechanical drying	S <sub>4</sub> D <sub>2</sub>
12	Whole cloves	Microwave drying	S <sub>4</sub> D <sub>3</sub>

## RESULTS AND DISCUSSIONS

The moisture content at regular intervals during the drying was noted. The curves were found to merge at the end as the sample reached the equilibrium point. The drying characteristics of different methods are described in succeeding paragraphs.

### Solar Drying of Garlic Samples

The drying characteristics of garlic samples were shown in Table 2. From table and figure it revealed that moisture loss during drying reduced as the drying time increased. Minimum drying time was found 26 h for chopped size of slice, S<sub>1</sub> followed by 27 h for 1 cm of slices size, S<sub>2</sub> and 28 h for half of the whole cloves of slices size, S<sub>3</sub>. Whereas maximum time required for drying of sample was found 30 h for whole clove (S<sub>4</sub>).

### Mechanical Drying of Garlic Samples

The drying characteristics of garlic samples were given in Table 2. It can be concluded that weight loss during drying reduced as the drying time increased. Minimum drying time was found 25 h for slices size of chopped, S<sub>1</sub> followed by 26 h for 1 cm slices size, S<sub>2</sub> and 27 h for slices size, S<sub>3</sub>, whereas maximum time required for drying of sample was found 29 h for slice size, S<sub>4</sub>.

### Microwave Drying of Garlic Samples

The moisture loss during drying reduced as the drying time increased Table 3. Minimum drying time was found 27 min for slices size, S<sub>1</sub> of followed by 28 min for slices size, S<sub>2</sub> and 29 min for slices size, S<sub>3</sub>. Whereas maximum time required for drying of sample was found 31 min for slices size, S<sub>4</sub>.

Table 2: Drying Characteristics of Solar and Mechanically Dried Garlic Samples

Drying Time(H)	Weight Loss (G)							
	Solar Drying				Mechanical Drying			
	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>4</sub>	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>4</sub>
0	115.00	115.00	115.00	115.00	115.00	115.00	115.00	115.00
1	106.00	107.00	108.00	110.00	106.20	107.00	108.00	109.20
2	100.00	102.30	103.00	105.20	99.21	102.00	103.20	104.00
3	94.40	96.00	97.50	99.00	93.70	94.20	95.50	96.40
4	90.00	91.00	92.00	93.00	88.00	89.30	90.20	91.30
5	86.00	87.00	88.20	89.50	84.00	85.20	86.30	87.30
6	82.00	83.00	84.00	86.00	80.00	81.30	82.20	83.20
7	79.00	80.00	81.00	83.00	76.00	77.20	78.10	79.30
8	76.00	77.00	78.00	80.00	73.10	74.30	75.10	76.30
9	73.00	74.00	75.00	78.00	70.00	71.20	72.30	73.20
10	70.00	71.00	72.00	74.00	66.90	68.00	69.40	71.00
11	67.00	68.00	69.00	71.00	63.60	64.20	65.40	66.60
12	64.20	65.30	66.20	68.00	60.80	62.00	63.40	65.40
13	61.30	62.00	63.00	65.00	58.10	59.20	61.90	63.50
14	58.40	59.00	60.20	62.00	56.00	57.30	59.30	61.00
15	55.00	56.20	57.00	59.40	54.00	55.40	57.40	58.40
16	52.30	53.00	54.30	56.00	52.00	53.50	55.40	56.20
17	49.90	50.96	51.20	54.00	50.80	51.60	53.80	54.30
18	46.00	47.00	47.70	51.00	49.10	50.40	51.50	52.50
19	44.00	45.52	44.20	50.00	47.70	48.00	50.00	51.00
20	43.00	43.81	42.00	49.00	46.33	47.30	49.10	50.10
21	42.10	41.89	41.40	48.00	44.90	46.00	48.00	49.00
22	41.00	41.54	41.00	47.00	42.80	45.10	47.00	48.00
23	40.21	41.21	40.50	46.00	41.76	45.00	46.10	47.00
24	40.00	41.10	40.20	45.00	41.40	44.60	45.20	46.30
25	39.83	40.87	40.54	44.00	41.00	43.30	44.20	45.00
26	39.64	40.69	40.12	43.00		42.20	44.00	44.30
27		40.44	40.05	42.60			43.40	42.80
28			40.00	42.20				41.80
29				42.00				41.50
30				41.00				

Table 3: Microwave Drying Characteristics of Garlic Samples

Drying Time (Min)	Weight Loss (G)			
	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>4</sub>
0	115.00	115.00	115.00	115.00
1	105.00	106.00	107.20	109.00
2	99.60	101.00	102.20	103.30
3	94.00	95.32	96.65	97.00
4	89.80	92.00	93.71	94.82
5	85.40	87.00	88.54	89.13
6	81.00	82.40	84.00	85.00
7	77.00	77.22	78.00	79.70
8	73.40	74.20	75.00	76.00
9	69.20	71.00	71.40	73.00
10	66.40	67.00	68.30	68.88
11	63.20	64.50	65.00	66.21
12	60.10	62.40	63.40	64.60
13	57.40	58.00	59.23	61.24
14	54.60	55.60	57.00	58.43
15	51.80	52.00	53.89	55.42
16	49.10	50.20	53.60	54.99
17	48.00	48.40	51.90	53.00
18	47.33	48.34	50.10	51.98
19	46.00	46.20	49.20	49.98
20	45.40	45.60	48.65	48.65
21	44.20	44.50	48.20	47.98
22	44.00	44.12	46.90	47.00
23	43.32	42.90	45.40	46.10
24	42.80	42.00	44.30	45.00
25	42.10	41.60	43.60	44.12
26	41.50	41.20	42.90	43.43
27	41.00	40.50	41.60	42.64
28		40.00	40.30	42.11
29			40.30	42.02
30				41.91
31				41.80

### Drying Time

The data shows that there were significant differences among slices size and drying methods Table 4. Irrespective of drying methods, significantly minimum time taken for drying was observed in S<sub>1</sub> (17.15 h), whereas maximum time for drying was observed in S<sub>4</sub> (19.84 h). Irrespective of slice sizes, significantly minimum time required for drying was noticed in microwave drying (0.48 h), whereas maximum time taken for drying was noticed in solar drying (27.75 h). The interaction effects between the different slices size and drying methods were also found significant. Minimum time taken for drying was observed in S<sub>1</sub> (0.45 h) under microwave drying, whereas maximum time taken for drying was observed in S<sub>4</sub> (30 h) under solar drying. The present findings are supported by Baysal *et al.* (2003) and Gupta *et al.* (1999). They observed that slices have been found to enhance the drying rate of garlic due to weight loss.

**Table 4: Effect of Different Slices Size, Drying Methods and their Combinations on Drying Time (H)**

Slices Size	Drying Method			Mean
	D <sub>1</sub>	D <sub>2</sub>	D <sub>3</sub>	
S <sub>1</sub>	26	25	0.45	17.15
S <sub>2</sub>	27	26	0.47	17.82
S <sub>3</sub>	28	27	0.48	18.49
S <sub>4</sub>	30	29	0.52	19.84
Mean	27.75	26.75	0.48	

Treatment	S.Em ±	CD at 5 % level
Slice size (S)	0.235	0.688
Drying method (D)	0.272	0.794
Interaction (S x D)	0.471	1.376

**Loss in Weight**

An examination of Table 5 revealed that the different slices size was non-significantly affected the final weight loss of garlic slices. The minimum final weight loss (70.27 g) was recorded in S<sub>4</sub>, whereas the maximum (73.72 g) was recorded in S<sub>1</sub>. Final weight loss of dehydrated garlic slices is non-significantly affected by drying methods. The maximum final weight loss (73.08 g) was observed in D<sub>3</sub> and minimum (70.62 g) in D<sub>2</sub>. The interaction effects between the different slices size and drying methods were also found non-significantly in dehydrated garlic slices. The highest final weight loss (75.16 g) was recorded in S<sub>1</sub> under D<sub>1</sub>, whereas the lowest final weight loss (68.50 g) was recorded in S<sub>4</sub> under D<sub>2</sub>. This is due to the effect of slices size, as the size is reduced more surface area is exposed and removal of moisture from the slice surface becomes faster. The present findings are supported by Baysal *et al.* (2003) and Avila *et al.* (1998).

**Table 5: Final Weight Loss of Dried Garlic Samples (G)**

Slices Size	Drying Method			Mean
	D <sub>1</sub>	D <sub>2</sub>	D <sub>3</sub>	
S <sub>1</sub>	75.16	72.66	73.33	73.72
S <sub>2</sub>	73.33	71.66	72.00	72.33
S <sub>3</sub>	72.16	69.66	71.83	71.22
S <sub>4</sub>	71.66	68.50	70.66	70.27
Mean	73.08	70.62	71.95	

Treatment	S.Em ±	CD at 5 % level
Slice size (S)	1.426	NS
Drying method (D)	1.646	NS
Interaction (S x D)	2.852	NS

**Final Weight**

Different slices size non-significantly affected the final weight of garlic slices. The minimum final weight (40.5 g) was recorded in S<sub>1</sub>, whereas the maximum (43.66 g) was recorded in S<sub>4</sub> Table 6. Final weight of dehydrated garlic slices is non-significantly affected by drying methods. The maximum final weight (42.5 g) was observed in D<sub>2</sub> and minimum (41.79 g) in D<sub>1</sub>. The interaction effects between the different slices size and drying methods were also found

non-significantly in dehydrated garlic slices. The highest final weight (44 g) was recorded in S<sub>4</sub> under D<sub>2</sub>, whereas the lowest final weight (39.83 g) was recorded in S<sub>1</sub> under D<sub>1</sub>. This is due to the effect of slices size, as the size is reduced more surface area is exposed and removal of moisture from the slice surface becomes faster. The present studies are broadly comparable with the corresponding values reported by Pawar *et al.* (1988).

**Table 6: Final Weight (G) of Garlic Samples as Influenced by Drying Method and Slices Size**

Slices Size	Drying Method			Mean
	D <sub>1</sub>	D <sub>2</sub>	D <sub>3</sub>	
S <sub>1</sub>	39.83	41.00	41.33	40.50
S <sub>2</sub>	41.33	42.33	41.66	41.77
S <sub>3</sub>	42.66	43.33	42.00	42.66
S <sub>4</sub>	43.33	44.00	43.66	43.66
Mean	41.79	42.51	42.16	

Treatment	S.Em ±	CD at 5 % level
Slice size (S)	1.075	NS
Drying method (D)	1.241	NS
Interaction (S x D)	2.151	NS

## CONCLUSIONS

On the basis of results obtained from the present investigation it can be concluded that most of the parameters of dried garlic slices were significantly influenced by different slices size, drying methods and their combinations. The treatment combination of S<sub>4</sub> under D<sub>2</sub> (whole clove x mechanical drying) was found best for most of parameters of dried garlic slices.

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